# De-oxygenation helps decommissioning at Wylfa, UK

Power | Case Study

## The Client

Magnox Ltd is part of Salt Lake City based EnergySolutions, a worldwide leader in the safe recycling, processing and disposal of nuclear material.

Under contract to the site owner, the Nuclear Decommissioning Authority, Magnox is responsible for 10 nuclear power plants in the UK including electricity generation and decommissioning at Wylfa, in Anglesey, North Wales.

The station commenced electricity generation in 1971, it was the last and largest power station of its type to be built in the UK.

## Key Figures

- Oxygen reduction to <100ppb to prevent corrosion
- Bespoke process design
- Engineering to nuclear industry standards

## The Client's Needs

Wylfa power station consists of two 490MW carbon dioxide gas cooled reactors, each driving two high pressure steam boiler and turbine generator sets. Each reactor has a 3,800 tonne graphite core containing over 49,000 natural uranium Magnox-clad fuel elements and 200 boron control rods to control the nuclear reaction.

Reactor 1 is still operational, but defueling has been commenced on Reactor 2. During defueling, cooling water will be circulated around the reactor and boilers until the reactor has been completely emptied of irradiated fuel. Each boiler has a capacity of 160m3 of demineralised water and, to reduce the chance of water leaks, it is essential that corrosion is minimised during this time.

To this end, Magnox chemists wanted to reduce the dissolved oxygen concentration of the water to less than 100ppb. Together with Project Manager, Paul Dundee and System Engineer, Robert Bradley, they turned to Veolia Water Technologies for help.

## The Solution

Veolia Water Technologies's solution was **membrane de-oxygenation. They designed and supplied a pilot plant for a two week trial on site in 2011, during which the dissolved oxygen concentration of the water was reduced from >10,000ppb (full saturation) to <100 ppb.**

Following a design review, incorporating lessons learned during the trial, Veolia Water Technologies later modified the pilot plant and supplied three more membrane de-oxygenation skids, one for each boiler circuit, to provide continuous oxygen removal and particle filtration.

Each skid includes process units to pre-treat and de-oxygenate the water together with monitoring equipment. The redesign includes full recirculation of the processed water, with a control panel providing all control and interlock functions.

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## Process Description

Incoming cooling water is initially filtered through two 50% duty 50µm bag filters and then pumped, using a variable speed booster pump, through two 50% duty 5µm bag filters for fine filtration to protect the downstream membranes. It is then fed to three stainless steel membrane degassing modules in series before returning to the cooling circuit.

The degassing modules use polypropylene membranes and are fed with nitrogen as a “sweep gas”. The sweep gas is drawn through the contactors by a vacuum pump. The partial pressure of oxygen on the sweep gas side of the membrane is very low and this results in oxygen transfer across the membrane from the water phase into the gas phase. All pipework is Schedule 10 316 stainless steel.

**Water reuse**
Both the influent water and treated water on each skid are monitored. Sample water from the analysers together with water from the vacuum separator is collected in a 50 litre tank and pumped back to the cooling system to ensure that there is no loss of water during normal operation.

**Compact design**
Limited access to the reactor annulus and restricted space for location and installation meant that the skids had to be designed to be as compact as possible whilst retaining operability. This is the first plant of this type to be used in the nuclear industry to help prevent corrosion.

**The Benefits**:

- No chemicals
- No waste stream
- Reduced cooling circuit maintenance costs

## Results

The three redesigned de-oxygenation skids were commissioned early in 2012 to ensure availability in April 2012. Dissolved oxygen is consistently less than the specified 100ppb.
**“For us, the pilot trials were crucial in ensuring that the membrane system would achieve the 100ppb.” says Paul**

Dundee. **“Both of the Reactor 2 systems are currently operating 24 hours per day and will continue to do so for another five to seven years. Being largely inert, it takes very little to operate and maintain the skids. The de-ox solution should significantly reduce corrosion in the cooling system, and that means fewer leaks, better security and lower maintenance costs.”**

The final two skids have been delivered, and due to the site’s on-going Generation Maximisation projects, will be installed and commissioned in 2016 when Reactor 1 is finally shut down.

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